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Do Native Plant Cultivated Varieties Perform Better than Their Wild Cousins?

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Abstract

Large numbers of native plant cultivars are regularly imported for re-vegetation and restoration into the semi-natural habitat of their wild cousins. It is hypothesized that cultivars and the wild cultivar hybrids are competitively superior to their wild relatives because cultivars are frequently selected for increased biomass output and may transfer these qualities into wild relatives through hybridization. Therefore, the introduction of such types could cause unexpected modifications to local plants. In this study, we investigated whether cultivars and artificially created intra-specific wild cultivar hybrids could produce a higher vegetative and generative biomass than their wild counterparts for two species that are frequently used in re-vegetation (Plantago lanceolata and Lotus corniculatus). A competitive experiment was carried out for that goal over the course of two growing seasons in a communal garden. Each plant type was either growing by itself, in pairwise combination with another plant type of a similar type, or in pairwise contact with another plant type [1]. When compared to the wild, hybrids produced more biomass than the wild in both of the research years, while cultivars of both species produced more biomass than the wild only in the first year. We come to the conclusion that cultivars and hybrids are competitively superior to their wild cousins because biomass production plays a significant role in determining fitness and competitive ability. Due to regional climatic circumstances, cultivars of both species, however, suffered significant fitness losses (almost full mortality in L. corniculatus). We come to the conclusion that cultivars are only effective competitors when they are not exposed to adverse environmental conditions. We consider hybrids to be strong competitors and believe they can outperform their wild counterparts, at least temporarily, because they appear to have inherited both the capacity to adapt to the local climatic conditions from their wild parents as well as the enhanced competitive strength from their cultivars.

Keywords: Plantago lanceolata; Lotus corniculatus; Germplasm; Pollen shed; Kernel

Introduction

Plants typically face crowding stress as plant density rises as a result of resource competition for nutrients, water, and good and bad light. Resource independent characteristics, such as resource utilisation effectiveness or light signaling, are suggested to be significant in other investigations of plant competition. A significant portion of the growing season is affected by the long-term, cumulative stress of overcrowding. Depending on the plant's genetic capacity, many abiotic stress conditions, such as drought, heat, shadow, and nutrient deficiencies, may occur concurrently under crowding stress. Because of this, biological mechanisms causing crowding stress may be more complicated than those causing other abiotic stresses alone [2].

The ability of the crop to retain yield per plant during increased plant population density (hereinafter referred to as simply "plant density") is known as plant density tolerance or "crowding stress tolerance." In the past fifty years, enhanced grain output has been considerably aided by the development of field corn hybrids with improved crowding stress tolerance. In contrast, it seems that less effort has been made to increase sweet corn, one of the most widely grown vegetables in North America, tolerance to crowding stress [3]. Processing sweet corn hybrids' plant densities that maximized yield varied by 22,100 plants ha-1, showing that commercial germplasm's tolerance to crowding stress varies greatly. Kernel mass per plant was the most significant indication identifying crowding stress tolerance and production among various phenotypic variables connected to crowding stress tolerance. Additionally, recent experiments on sweet corn showed a large economic benefit when crowding stress-tolerant hybrids at plant densities greater than usual. Given the positive correlation between crowding stress tolerance and profitability, such variation in crowding stress response will offer untapped genetic potential to raise not only the production but also the profitability of sweet corn [4].

In controlled settings or in the field, transcriptional profiling of different abiotic stresses, including field corn response to both intra- and inter-specific competition, were investigated. Field maize and barley seedlings were subjected to crowding stress and the genes responsible for this stress were discovered [5]. To link plant response to crowding stress tolerance and to uncover potential crowding stress tolerance pathways, transcriptional analysis of several sweet corn hybrids under crowding stress has been carried out. The study demonstrated that each hybrid had unique strategies for mitigating the effects of crowding. Furthermore, some gene modules were linked to plant or ear traits, while others were linked to crop yield response [6-8]. On the other hand, it is hypothesized that increasing the number of distinct environmental setups in addition to replication will yield reliable and repeatable molecular and transcriptional results on abiotic stress. Understanding the complicated nature of crowding stress will be aided by transcriptional responses to crowding stress under various environmental situations.

The molecular pathways involved in crowding stress tolerance that

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affect sweet corn yield are of agronomic importance. The majority of crowding stress transcriptional studies was done in the early or late vegetative stages. However, flowering is also one of the growth stages that is most vulnerable to stress, particularly during the times when silk growth, pollination, and kernel setting take place. By establishing a link between the stress response during the vegetative stage (before flowering) and the later growth stage, transcriptional alterations during blooming will enhance our comprehension of the resistance to crowding stress (at flowering) [9]. Additionally, the crucial "source" of assimilate that influences stressed-out kernel production is the ear leaf. Studies revealed that photosynthesis on the five or six leaves close to and above the ear has a significant impact on the accumulation of photosynthate in the kernel. In order to 1) investigate the phenotypic and transcriptional response of sweet corn hybrids under various plant densities, 2) compare the mechanisms of hybrid crowding stress response, and 3) identify potential biological mechanisms involved in crowding stress response, research was done on sweet corn [10].

Discussion

Between-type competition

Our findings on between-type competition reveal that in both species, cultivars are at least briefly in competition with wilds. This is because in the first growing season, cultivars were fitter than wilds due to their higher allocation of vegetative and generative biomass. This outcome is consistent with tall grass prairie restoration findings in North America. By the end of the second season of our trial, the cultivars' advantage had, however, vanished [11]. As the lower biomass production in P. lanceolata cultivars and the high mortality in the L. corniculatus cultivar were unrelated to competition, the reduced fitness in cultivars in our experiment was most likely caused by the exceptional long and cold winter conditions in 2010/2011 rather than by competition. Up to the end of the experiment, the wilds in our study fared better with the local climate than their cultivar counterparts. We made the assumption that changes in trade-offs between plant features by cultivation in a previous study. Due to changes in resource allocation, selection for big biomass output may have also entailed selection against the capacity to withstand severe environmental circumstances in this instance. Cultivars could not be well adapted to severe environmental conditions like frost as a result. Lower resistance to pest infestation may also be a consequence of such trade-offs [12]. Cultivars can only be superior in a competitive sense if they are not exposed to severe environmental variables.

Between-type competition vs. within-type competition

In contrast to our assumptions the fitness of wilds in competition with cultivars and hybrids (between-type competition) was not inferior to the fitness of wilds in rivalry with other wilds. This result is seen by us as a significant "competitive reaction". Regardless of whether they are of the same plant kind, the wilds are probably capable of withstanding resource decrease by rival neighbors over the near run.

However, greater biomass allocation in cultivars in competition with wilds than in cultivars in competition with cultivars also suggests potential competitive superiority of cultivars over their wild counterparts at least in the first growing season as detected in between-type competition trials (Hypothesis 1). (Within-type competition). As a result, in the first growing season, there is less between-type competition with wilds than there is within-type competition for cultivars. When compared to competition with hybrids, the hybrids' propensity for competitive superiority over their wild counterparts in our study was also strongly accompanied by greater fitness in competition with wild counterparts (between-type competition). As a result, in both growing seasons, hybrids experience less between-type competition with wilds than within-type competition.

Conclusion

To increase sweet corn productivity and profitability, it is necessary to take advantage of genetic variability in resistance to crowding stress. Increasing plant ability to preserve individual plant output by reducing kernel abortion and maximizing biomass allocation under stress conditions would be one of the biological goals that hold the most biological promise for tolerating crowding stress and achieving maximum productivity. The present work identified genes and biological processes involved in crowding stress response by comparing plant yield responses to plant densities and recording gene expression relevant to kernel formation. The genes involved in protein folding and photosynthesis were generally significant for the crowding stress response. However, genes associated with glucose metabolism, starch biosynthesis, and ABA related processes were significant in the crowding stress-tolerant hybrid, indicating they may have direct relevance to enhancing production under crowding stress.

Acknowledgement

None

Conflict of Interest

None

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